SENIOR HIGH SCIENCE

SCIENCE 14-24

PROGRAM OF STUDIES

IMPLEMENTATION - SEPTEMBER 1989

CURRICULUM DESIGN BRANCH

Alberta
EDUCATION

A. PROGRAM RATIONALE AND PHILOSOPHY

Senior high school education is intended to prepare young people for entry into the workplace, to prepare them for further learning in other environments, and for living in an increasingly complex society.

The focus for senior high education is on learning to access and apply knowledge and information. For senior high science, this means not only the use of knowledge and information, but the development of an understanding of the pervasive role of science and technology in our society and in our own lives. Significant outcomes of senior high science education include awareness of the harmony required between science and the environment, and awareness of oneself as a member of the global community, with consequent inherent responsibilities to that community.

To ensure that students become both scientifically literate and socially responsible, science curricula must combine specific science content and process skills with content that empowers students to understand the interaction between science, technology, and society.

The science curriculum addresses the specialized scope and subject matter appropriate for students who will later pursue science as a discipline, as well as the needs of the larger group who will, after graduation, pursue a broader range of interests and aspirations. Students must be equipped to make wise choices based on an understanding of the relationships among science, technology, and society .

The Science 14-24 program provides a two-course science sequence that allows students to meet the credit requirements of the General High School Diploma. It is an activity-based program, providing students with the opportunity to develop and use practical knowledge of scientific principles and process. The attitudes, skills, and concepts, wherever possible, are developed within the context of the student's own experience through the use of familiar, concrete examples: development of attitudes, skills, and concepts through active participation, and exploration of science-technology and science-technology-society relationships. These all serve to motivate, to maintain interest and to encourage a continuing appreciation of science for its usefulness and relevance. The Science 14-24 program promotes decision-making skills through active investigation of science-related issues. A practical, working knowledge of science, coupled with the ability to make informed and responsible decisions, will result in a "scientifically literate" student, able to understand and debate science-related issues and capable of making informed choices.

B. GENERAL LEARNER EXPECTATIONS

Attitudes

1. Scientific Attitudes

Students will be encouraged to develop the affective attributes of scientists at work including

1.1 curiosity
1.2 respect for evidence
1.3 inclination to tolerate uncertainty
1.4 intellectual honesty
1.5 open-mindedness
1.6 critical-mindedness
1.7 perseverance
1.8 creativity and inventiveness
1.9 appreciation for group work
1.10 suspended judgment
1.11 objectivity
1.12 confidence in personal ability; and
1.13 respect for accuracy and precision.

2. Attitudes Toward Science

Students will be encouraged to develop the feelings, opinions, beliefs and appreciations which individuals have formed as a result of interacting with the various aspects of the scientific enterprise, including

2.1 a positive attitude toward mathematical and scientific process skills
2.2 an appreciation for the utility of computational competence and problem-solving skills
2.3 an appreciation that, in solving problems scientifically, new technologies develop
2.4 an appreciation of the roles that science and technology play in serving human needs
2.5 an appreciation of the need for problem solving and informed decision-making at both personal and societal levels
2.6 an appreciation of the contributions science and mathematics have made to our cultural heritage and civilization
2.7 an appreciation of the contributions and limitations of scientific and technological knowledge to societal decision-making
2.8 an appreciation that ethical dilemmas may arise from the application of scientific research and/or technological developments
2.9 a sensitivity to the living and non-living environment; and
2.10 an appreciation of the roles of science and mathematics in explaining the complexity of the natural world.

Skills

1. Initiating Skills

Students will be expected to demonstrate an ability to distinguish between relevant and irrelevant information early in the cognitive process by

1.1 defining problems
1.2 identifying issues

1.3 setting goals by establishing direction and purpose
1.4 formulating questions to guide research/inquiry
1.5 identifying variables and assumptions.

2. Information-Gathering and Data-Collecting Skills

Students will be expected to demonstrate an ability to consciously consider the substance or content to be used in the cognitive process by

2.1 using an experimental design or research plan to gather data/information
2.2 obtaining qualitative and quantitative data
2.3 accessing relevant information
2.4 assembling and effectively using apparatus and equipment
2.5 recording data.

3. Organizing Skills

Students will be expected to demonstrate an ability to arrange or structure information so it can be understood or presented more readily by

3.1 classifying
3.2 comparing/contrasting
3.3 ordering and identifying patterns and trends
3.4 drawing graphs, charts, flow charts, maps, and diagrams
3.5 expressing data in the form of a mathematical relationship.

4. Analyzing Skills

Students will be expected to demonstrate an ability to classify existing information by examining parts and relationships, and to identify and distinguish components, attributes, claims, assumptions, or reasons by

4.1 interpreting data or information
4.2 judging the reliability or validity of the data or information
4.3 identifying errors
4.4 distinguishing between facts and values; relevant and irrelevant information
4.5 identifying main ideas
4.6 identifying attributes and components
4.7 identifying relationships and patterns
4.8 identifying perspectives; and
4.9 detecting bias and inconsistencies in a line of reasoning.

5. Generating Skills

Students will be expected to demonstrate an ability to make connections among new ideas and prior knowledge, and to add information beyond what is given by

5.1 predicting
5.2 hypothesizing
5.3 explaining and elaborating
5.4 inferring and generalizing from the data or information
5.5 designing experiments or devising a plan for research
5.6 identifying and developing alternatives; and
5.7 identifying further problems, questions, and issues to be investigated.

6. Integrating Skills

Students will be expected to demonstrate an ability to combine new information and prior knowledge by

6.1 summarizing and communicating findings
6.2 developing consensus within a group
6.3 making a decision; developing a conclusion/solution
6.4 incorporating new information into existing theories or knowledge
6.5 changing existing knowledge structures to incorporate new information.

7. Evaluating Skills

Students will be expected to demonstrate an ability to assess the logic and quality of ideas and information by

7.1 considering consequences
7.2 establishing criteria to judge reliability and validity of the data or information
7.3 assessing a design or the approach taken to solving problems and decision-making
7.4 assessing the achievement of the goals set and action taken.

Concepts

1. Foundation of Knowledge in the Natural Sciences

Students will be expected to demonstrate an understanding of ideas fundamental to science, including

1.1 matter has structure and composition and there is an interaction among its components
1.2 matter and energy are conserved in reaction systems
1.3 living organisms are interdependent with one another and with their environment
1.4 life forms exhibit uniquity, diversity, and a changing nature
1.5 physical laws and theories attempt to explain the universe
1.6 chemical and physical systems are in a state of dynamic equilibrium; and
1.7 the application of knowledge is part of a systematic interpretation of natural phenomena.

2. Nature of Science

Students will be expected to demonstrate an understanding of science as a disciplined way to develop explanations for natural phenomena, including

2.1 empirical evidence plays an important role in the development of scientific knowledge
2.2 scientific explanations are developed through interpretations and conceptual inventions which are theoretical in nature
2.3 proposed theories may be supported or refuted by experimental evidence
2.4 scientific knowledge is cumulative and subject to change.

3. Science and Technology

Students will be expected to demonstrate an understanding of the interaction between science and technology, including

3.1 technology is a process of solving practical problems
3.2 technological development includes both products and processes
3.3 technology is a rapidly evolving area in modern society requiring ongoing study
3.4 the functioning of products and processes may be explained using scientific knowledge
3.5 science can be used to advance technology and technology can be used to advance science; and
3.6 scientific knowledge and technology have limitations.

4. Science, Technology, and Society

Students will be expected to demonstrate an understanding of how science and technology influence, and are in turn influenced by, societal issues, including

4.1 many of the effects of science and technology on society are unforeseen
4.2 societal factors, such as economic, political, ethical, and moral forces, interact with science and technology, exerting significant influence on each
4.3 technological products and processes develop in response to societal needs and wants
4.4 compromises are often needed to arrive at workable situations involving science and technology in society
4.5 various societal decisions can be evaluated in terms of related scientific and technological thinking; and
4.6 the scientific, technological, and societal aspects of an issue can be identified through appropriate research and communication.

C. SPECIFIC LEARNER EXPECTATIONS

The Science 14-24 program has a required and an elective component, defined as follows:

- The required component provides the Specific Learner Expectations within the required units of study and comprises 80% of the program.

- The elective component provides opportunities to adapt and enhance instruction to meet the diverse needs, abilities, and interests of individual students. This component of the course may consist of remediation and enrichment, or one of the optional units outlined below and comprises 20% of the program.

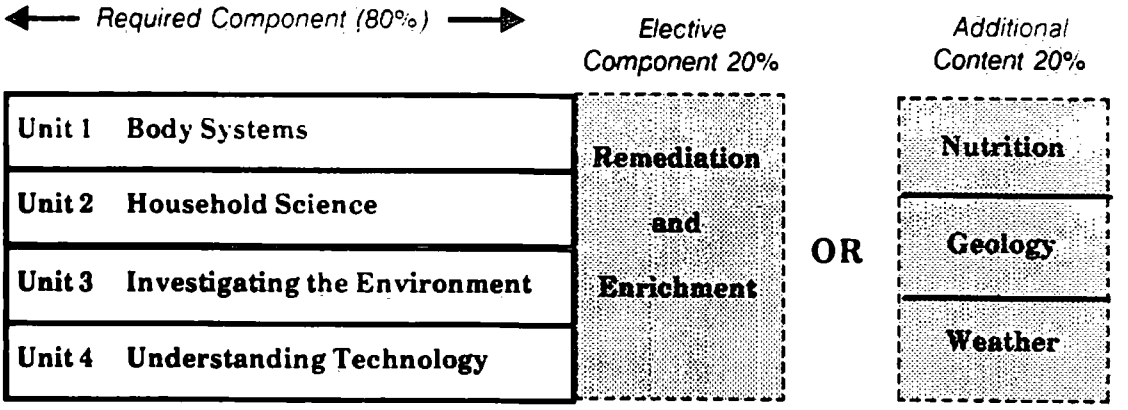
The elective component can be used for:

enrichment of the required component of the program to provide challenges and depth; remediation of the required component to provide additional assistance and reinforcement; or additional learnings to provide alternative instructional activities consistent with the learner expectations of the required component.

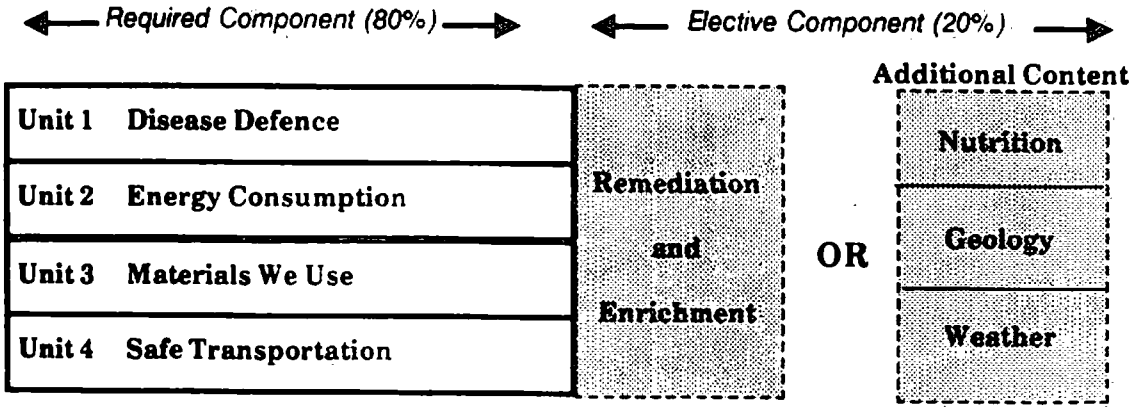
For Science 14 course (five credits), all four required units must be completed.

For Science 24 (five credits), all four required units must be completed. If Science 24 is offered for three credits, any two of the four required units must be completed.

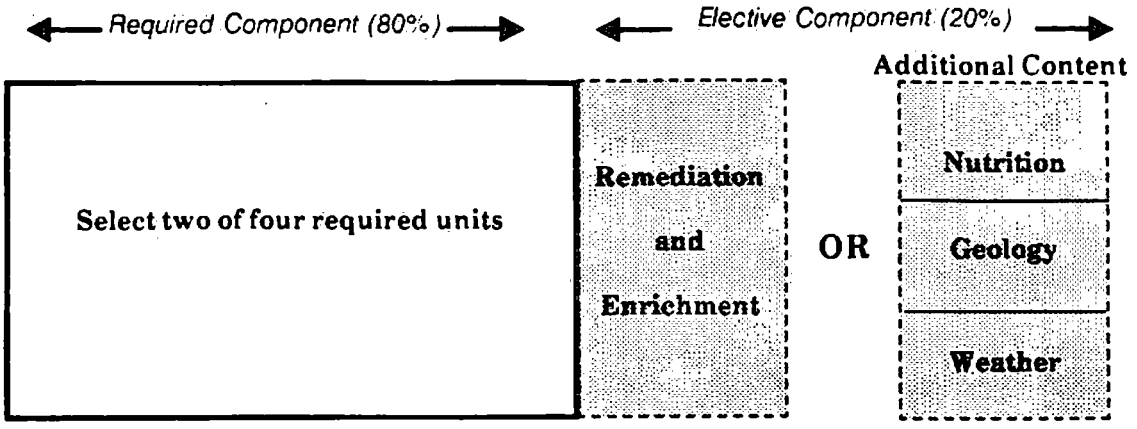
Science 14 (5 credits)



Science 24 (5 credits)



Science 24 (3 credits)



Elective time should be spent in a manner best suited to the nature and needs of the learner.

Three optional units are provided. Optional units serve as possible elective component material, either as enrichment or additional content. A teacher may select one or more of these suggested optional units to serve as elective for either the Science 14 or Science 24 courses. These optional units are not intended to be prescriptive but to serve as models. Optional units may be developed or selected locally, subject to the following provisions being met.

1. All optional program content must support the General Learner Expectations of the program.

2. Inclusion of optional content must not detract from the achievement of the Specific Learner Expectations of the required component of the program.

Any optional unit taught becomes part of the 20% elective component of the program. Additional topic suggestions are included in the Teacher Resource Manual.

SCIENCE 14

Required Unit 1: Body Systems

Overview

Through the application of scientific investigation, and the incorporation of simple monitoring technology, students will be encouraged to develop an understanding of the human body as a collection of dynamically balanced processes. The contribution of science to the current knowledge and technology associated with an aspect of the functioning human body will be identified. Knowledge gained should be personally applicable and form a foundation for understanding the life processes of all living organisms.

Attitudes

Students will be encouraged to

- appreciate the potential for advancement of knowledge through scientific inquiry
- respect the method of scientific investigation for its contribution to current knowledge of body systems and their interactions
- value the contribution of technology to the scientific investigations related to human health
- appreciate the intricate workings and balance within the human body
- value knowledge gained for its usefulness on a personal level
- value knowledge gained for its general application to all living things.

Skills

Students will be expected to demonstrate an ability to

- question, observe, measure, collect, process, and interpret data while investigating body systems
- apply monitoring technology in the collection of personal data for analysis.

Concepts

1. *Students will be expected to* demonstrate an understanding that science is a disciplined way to develop explanations for body functions.

   1.1 Illustrate with an example that much of our current knowledge of body systems has developed as a result of scientific inquiry.
   1.2 Outline a scientific investigation of a specific body function.
   1.3 Deduce that the knowledge of body systems is constantly expanding through scientific research.

2. *Students will be expected to* demonstrate an understanding that medical technology can be used to monitor body conditions.

   2.1 Describe the role of technology in monitoring critical life functions.
   2.2 Describe the contribution of technology to the diagnosis of malfunction within body systems.
   2.3 Explain using an example how science and technology work together to expand knowledge of body systems, providing information that can be applied to prevention of potential problems.
   2.4 Describe how technology can intervene to preserve the balance of life when a system fails (temporary and permanent intervention).

3. *Students will be expected to* demonstrate an understanding that a healthy body is the product of body systems working in harmony.

   3.1 Identify the critical life functions and the body system(s) that perform(s) them.
   3.2 State how each body system has a particular function critical to life.
   3.3 Describe two body systems and their functions.
   3.4 List the structures within those two body systems.
   3.5 State the functions associated with each of those structures within the two systems.
   3.6 Analyze the functional relationship of these two systems.

4. *Students will be expected to* demonstrate an understanding that the interrelationships of body systems are critical to life.

   4.1 Explain how normal fluctuation within one body system results in adjusting fluctuations in other body systems.
   4.2 Analyze the effect of a major fluctuation within the normal limits of one of the two systems studied.
   4.3 Extrapolate the concept to include the interrelationships of all body systems.
   4.4 Deduce that illness and possibly death results when the body cannot accommodate major disturbances within one or more of its systems.

5. *Students will be expected to* demonstrate an understanding that living things share common life functions.

   5.1 Describe how critical life functions are performed by unicellular organisms, plants, and animals.
   5.2 Generalize and apply knowledge gained about human life functions to other living systems.

Required Unit 2: Household Science

Overview

By carrying out a series of controlled experiments, students will identify properties of substances found in their homes. They will be expected to develop a strategy for the safe handling of potentially dangerous substances and situations encountered within the home environment.

Attitudes

Students will be encouraged to

- value scientific principles and processes for their usefulness in providing an understanding of common household phenomena
- appreciate that science exists outside of the classroom and laboratory
- value measurement for its usefulness in the household
- appreciate the benefit and potential danger of common household chemicals
- appreciate the contribution of technological products and processes to the modern household.

Skills

Students will be expected to demonstrate an ability to

- improve measurement skills
- refine observation skills
- use data collecting, processing and interpreting skills
- communicate experimental results clearly
- read consumer labels and reports with accuracy and understanding
- determine household product composition through investigation and/or accurate label reading
- determine the properties of pure substances and solutions through investigation
- apply acid and base identification techniques

- protect living organisms and materials from excessive heat transfer
- handle food safely
- handle potentially dangerous household products safely.

Concepts

1. *Students will be expected to* demonstrate an understanding that household activities often require knowledge of measurement techniques.

   1.1 Use a variety of measurement techniques common in a household.
   1.2 Use common household measurement devices correctly.

2. *Students will be expected to* demonstrate an understanding that household products and processes are based on the principles of science.

   2.1 Identify some basic household processes (such as cleaning, laundry, baking, and painting) which are based on scientific principles.
   2.2 Identify the products involved in these processes (e.g., detergents, solvents, leavening agents).
   2.3 Explain the composition of a household product.
   2.4 Describe the scientific principles that underlie the effectiveness of a household product or process.

3. *Students will be expected to* demonstrate an understanding that the properties of solutions are different than those of pure substances.

   3.1 Describe the properties of solutions and pure substances.
   3.2 Identify pure substances found in a household.
   3.3 Identify solutions found in a household.
   3.4 Differentiate solutions and pure substances, using selected household examples.

4. *Students will be expected to* demonstrate an understanding that permanent suspensions are found in the home.

   4.1 Describe the properties of permanent suspensions.
   4.2 Identify common permanent suspensions found in the home.
   4.3 Deduce the importance of permanent suspension by examining the consequences of separation to relevant household products.

5. *Students will be expected to* demonstrate an understanding that acids and bases can be identified and their reactions observed in the home.

   5.1 Describe the necessity for accurate identification of these substances.
   5.2 Describe how acids and bases can be identified.
   5.3 Illustrate with an example how acids and bases can react with other household substances in both useful and potentially dangerous ways.

6. *Students will be expected to* demonstrate an understanding that solubility varies with temperature change.

   6.1 Demonstrate how temperature change affects solubility of one common household solute.

6.2 Cite common household examples of temperature change affecting solubility (e.g., brine preparation in pickling; syrup preparation in canning of fruit; making jello; homemade syrup).
6.3 Describe why certain solutes crystallize out as temperature drops and explain the concept of saturation point.

7. *Students will be expected to* demonstrate an understanding that reactions may require or emit energy in the form of heat.

7.1 Describe the types of household reactions that require heat.
7.2 Describe different household chemical reactions that would produce heat.
7.3 Evaluate the usefulness of household reactions that require or emit heat.

8. *Students will be expected to* demonstrate an understanding that heat flows from areas of high temperature to areas of lower temperature.

8.1 Compare heat exchange by conduction, convection, and radiation in different mediums.
8.2 Determine the mode of heat transfer involved in various household processes.
8.3 Describe how household products, devices, and techniques are designed to increase or decrease heat flow for specific purposes.
8.4 Describe the potential dangers of heat transfer.

9. *Students will be expected to* demonstrate an understanding that many household substances require special care in their use and handling.

9.1 Identify substances that have safety labelling.
9.2 List reasons why reading instructions for safe handling is important.
9.3 Describe recovery techniques for common problems or errors in handling.
9.4 List the potential dangers of mixing common household products.
9.5 Describe how micro-organisms can have beneficial and harmful effects on food material in the home.

Required Unit 3: Investigating the Environment

Overview

Students will identify a problem that arises from a selected environmental issue. They will investigate the problem, identify any technology relating to the problem, and suggest a process or action plan to deal with the selected environmental issue.

Attitudes

Students will be encouraged to

- appreciate the fragility of the biosphere
- realize our inability to anticipate the environmental effects of our human activities
- develop optimism with respect to man's ability to live in harmony with the environment
- develop a sense of personal responsibility and empowerment in relation to environmental issues

- appreciate that the collective action of individuals can have significant impact
- develop healthy skepticism in regard to technology as the ultimate solution to environmental issues
- appreciate that environmental issues involve significant relationships among science, technology, and society.

Skills

Students will be expected to demonstrate an ability to

- identify a problem associated with an environmental issue
- gather, organize, and evaluate such information
- clearly communicate the results of the investigation
- apply resulting information to a personal and/or societal situation.

Concepts

1. *Students will be expected to* demonstrate an understanding that humans have the ability to influence the quality of the environment.

   1.1 List technological developments that produce materials the ecosystem cannot recycle.
   1.2 Identify the relationship between densely populated areas and the production of wastes that exceed the environment's capacity to recycle.
   1.3 Describe how land-use practices may result in major changes to the environment.
   1.4 Give examples of how technological and societal developments can improve the quality of the environment.

2. *Students will be expected to* demonstrate an understanding that science and technology influence, and are influenced by, societal issues.

   2.1 Give examples of how science and technology develop in response to societal needs.
   2.2 Describe how scientific and technological developments, while meeting human wants and needs, may create or intensify problems (e.g., pollution).

3. *Students will be expected to* demonstrate an understanding that the effects of science and technology on society and on the environment are often unforeseen.

   3.1 Identify examples of the unforeseen consequences of science and technology (e.g., nuclear fission, automobiles, herbicides and pesticides).
   3.2 Identify and analyze the circumstances that led to unforeseen consequences in one particular case.
   3.3 Evaluate the societal impact of a development in science and technology.

4. *Students will be expected to* demonstrate an understanding that individuals can become involved in the resolution of ecological problems which arise.

   4.1 Identify ways that society can affect science and technology, exercising some degree of direction and control through political and consumer pressure (e.g., provision of fiscal and manpower resources, legislation, enforcement, petition, voting, demonstrations).
   4.2 Identify the ways an individual, as a member of society, can provide a degree of direction and control for science and technology (letters to MP's, lobby groups, personal habits).

5. *Students will be expected to* demonstrate an understanding that the biosphere is a thin layer on the surface of the earth, able to support life.

   5.1 Identify the components of the biosphere that provide the essentials of life.

6. *Students will be expected to* demonstrate an understanding that a continuous supply of solar energy is essential to life.

   6.1 Describe how the flow of solar energy through the biosphere is non-cyclical.
   6.2 Explain how photosynthesis and respiration are involved in the energy conversions necessary for life.
   6.3 Trace energy transfer from one feeding level to another, identifying loss of heat energy at each transfer.

7. *Students will be expected to* demonstrate an understanding that life depends on recycling processes.

   7.1 Explain why biochemical cycles are necessary to recycle matter.
   7.2 Identify the role of decomposers in the recycling process.
   7.3 Specify how biodegradable materials reduce the impact of man-made products on the environment.

8. *Students will be expected to* demonstrate an understanding that an ecosystem is the interaction of a community with its physical environment.

   8.1 List the physical factors which limit population growth.
   8.2 Describe how interaction between organisms affects populations.
   8.3 Illustrate with at least one example the impact organisms have on the environment.

Required Unit 4: Understanding Technology

Overview

Students will construct and/or manipulate and examine a simple device to determine the scientific principles upon which the operation of the device depends.

Attitudes

Students will be encouraged to

- develop a positive attitude toward scientific and technological processes and skills
- appreciate that in solving problems scientifically, new technologies develop
- develop an awareness that science may involve technology and technology may involve science
- appreciate the importance of evaluating the design of a given technological device
- appreciate the relationships among science, technology, and society.

Skills

Students will be expected to demonstrate an ability to

- select and observe natural phenomena
- select a current technology and identify the specific interrelationships that exist between science and technology
- construct or acquire at least one simple device
- test the operation of the device
- evaluate the performance of the device
- identify the scientific principles utilized by the device
- identify a need or want not currently satisfied by a modern technology
- create an original design for one of the above needs or wants
- communicate how a specific technology has personal application.

Concepts

1. *Students will be expected to* demonstrate an understanding that science is the study of natural phenomena.

   1.1 Illustrate with at least one example how observation of natural phenomena can lead to scientific inquiry.
   1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.

2. *Students will be expected to* demonstrate an understanding that science is founded on facts, laws, and theories.

   2.1 Differentiate among the terms *fact*, *law* and *theory*.
   2.2 Identify the relevant scientific facts, laws, and theories associated with the use of a simple device or observable phenomena.

3. *Students will be expected to* demonstrate an understanding that science can be used to advance technology and technology can be used to advance science.

   3.1 Identify situations where science leads to advances in technology.
   3.2 Identify situations where technology leads to advances in science.

4. *Students will be expected to* demonstrate an understanding that people create technological devices and systems to satisfy needs and wants.

   4.1 Illustrate with at least one example the application of scientific principles in the development of modern devices.
   4.2 Identify a variety of human needs and wants, and list the technological devices developed to meet them.

SCIENCE 24

Required Unit 1: Disease Defence

Overview

Students are to become aware of common diseases and their effect on our society. The technology involved in the study, treatment, and cure of these diseases will be investigated.

The human immune system, immunization, and current related biotechnology will be major areas of study.

Attitudes

Students will be encouraged to

- appreciate that in solving problems scientifically, new technologies often develop
- appreciate that ethical dilemmas may arise from the application of scientific research and/or technological developments
- appreciate the relationship among science, technology, and society
- develop a responsible attitude toward disease prevention
- develop an awareness of the limits of science and technology in regard to control and cure of human disease.

Skills

Students will be expected to demonstrate an ability to

- identify, use, and evaluate various methods of problem solving
- apply data collection, organization, and interpretation skills
- recognize the limits of science and technology
- develop skill in the use of a light microscope/microslide viewer
- observe and identify basic cell structures visible under the light microscope/microslide viewer
- implement basic principles of disease prevention that contribute to human health.

Concepts

1. *Students will be expected to* demonstrate an understanding that diseases can be communicable or noncommunicable.
   - 1.1 Trace the historical development of the disease concept.
   - 1.2 Describe how communicable diseases are transmitted by microbes such as viruses, bacteria, protists, and fungi.
   - 1.3 Describe how noncommunicable diseases result from an interaction of variables (e.g., poor nutrition, compromised immune system, stress, heredity, alcohol, smoking).
   - 1.4 Describe the steps that can be taken to reduce the risk of contracting disease.

2. *Students will be expected to* demonstrate an understanding that the microscope is an essential tool for looking at microbes and cells.

   2.1 Relate structure to function in a light microscope.
   2.2 Describe how the invention of the electron microscope made possible the study of viruses and extremely small structures within the cell, which in turn led to great advances in science.

3. *Students will be expected to* demonstrate an understanding that the human body has natural systems of immunity.

   3.1 Describe how immunity can be achieved through contact with specific diseases.
   3.2 Describe how antibodies and phagocytes function as major components of the body's defence/immune system.
   3.3 Explain that through placental transfer and breast milk, maternal system antibodies pass to the offspring, providing some degree of immunity to the child.
   3.4 Identify examples of abnormal immune responses (e.g., allergies, AIDS).

4. *Students will be expected to* demonstrate an understanding that biotechnical and biomedical processes have greatly enhanced our immune systems.

   4.1 Explain why aseptic technique is critical to modern medical practice (historical development).
   4.2 Relate how artificial immunization (vaccines) prevents the contraction of many diseases.
   4.3 Describe how antibiotics suppress bacterial growth.
   4.4 Identify advances in genetic research which relate to disease defence (e.g., the splicing and cloning of genes to make antibodies).

5. *Students will be expected to* demonstrate an understanding that immunization technology is based on scientific principles.

   5.1 Trace the historical development of immunization therapy (Jenner, Pasteur, Koch, Salk).
   5.2 Describe how the body recognizes a foreign substance (antigen) and can produce specific antibodies against it.
   5.3 Describe how immunity can be induced by injection with attenuated or killed micro-organisms (e.g., measles, mumps, polio, rabies).
   5.4 Outline how injection of antibodies directly into an individual results in passive immunity (e.g., tetanus, hepatitis).

6. *Students will be expected to* demonstrate an understanding that factors behind biotechnical and biomedical processes have societal implications.

   6.1 Explain that vaccines provide immunity against diseases that were formerly fatal.
   6.2 Cite two examples of transplants or implants that may increase life expectancy.
   6.3 Identify and describe two techniques for genetic screening that make it possible to detect genetically transmitted diseases and disorders.
   6.4 Describe the interaction of a biomedical process with science and society.
   6.5 Cite one example of scientific research into the diseases of domestic crop plants leading to the development of technology which allowed the production of disease-resistant strains.

Required Unit 2: Energy Consumption

Overview

Students will use observation and recording of personal energy consumption patterns to establish a data base. Analysis and application of this data should lead to an awareness of technological processes involved in personal and global energy consumption.

Attitudes

Students will be encouraged to

- develop a positive attitude toward mathematical and scientific process skills
- develop responsible attitudes toward energy consumption in relation to personal and global needs
- be receptive to new ideas, insights, and change.

Skills

Students will be expected to demonstrate an ability to

- select and apply appropriate problem-solving strategies
- apply specific data collection, organization, and interpretation skills
- identify trends in data and make predictions from those trends
- use precise symbols and terminology
- use simple calorimetry to measure the energy output of various foods
- use simple equipment and techniques to measure two other forms of energy (e.g., light, sound)
- apply monitoring techniques and record personal kilojoule intake
- analyze data from a personal kilojoule intake record
- develop an improved diet plan based on the analysis
- apply monitoring techniques and record a personal household's energy consumption
- analyze data from a personal household energy consumption record
- devise a more efficient plan for household energy consumption based on the analysis
- devise a simple energy system model to demonstrate the conservation of energy
- calculate the efficiency of a basic energy system.

Concepts

1. *Students will be expected to* demonstrate an understanding that we obtain energy from the foods we consume.

   1.1 Identify the sun as the ultimate source of food energy.
   1.2 Describe the body systems responsible for conversion of food into energy.
   1.3 Identify and describe the processes of energy conversion performed by the human body.
   1.4 Identify the basic components of a balanced diet.

2. *Students will be expected to* demonstrate an understanding that energy can be measured in quantitative terms.

   2.1 Identify and define the units for measuring energy from food.
   2.2 Examine calorimetric equipment and techniques for measuring food energy.
   2.3 Identify other forms of energy present in the world.
   2.4 Identify equipment, techniques, and units used to measure other forms of energy.

3. *Students will be expected to* demonstrate an understanding that personal energy consumption can be determined.

   3.1 Identify the forms of energy used in the household.

4. *Students will be expected to* demonstrate an understanding that observable phenomena play a role in the development of scientific knowledge.

   4.1 Describe how energy consumption data can be applied to make energy use more efficient.

5. *Students will be expected to* demonstrate an understanding that energy within a system has input, conversion, and output components.

   5.1 Identify the energy components within a system.
   5.2 Describe the flow of energy within the human body.
   5.3 Describe the flow of energy through an ecosystem.
   5.4 Investigate energy consumption, conversion, and output within an energy-powered device.

6. *Students will be expected* to demonstrate an understanding that total energy of a system is conserved.

   6.1 State the law of conservation of matter and energy.
   6.2 Explain the law of conservation of energy in terms of a selected energy system model.

7. *Students will be expected to* demonstrate an understanding that efficiency of an energy system can be calculated.

   7.1 Describe the methods and techniques for determining the efficiency of an energy system.
   7.2 Suggest ways of improving the efficiency rating of an energy system.
   7.3 Compare and contrast two energy systems in terms of their overall efficiency.

8. *Students will be expected to* demonstrate an understanding that there are renewable and non-renewable energy sources.

   8.1 Differentiate between renewable and non-renewable energy sources.
   8.2 Identify and describe one non-renewable and one renewable energy source.
   8.3 Describe ways of using renewable energy sources to improve the efficiency of local and global energy consumption.
   8.4 Discuss the effects of using non-renewable sources on local and global energy consumption.

Required Unit 3: Materials We Use

Overview

Students will study a variety of materials and their application. The interaction of science and technology in the research, development, and production of materials to satisfy a societal demand will be addressed. The relationship of the properties of a specific material to its application will become evident through personal scientific investigation.

Attitudes

Students will be encouraged to

- be aware that the technology of materials can solve practical problems
- appreciate the relationship of science principles to the properties of common materials
- appreciate the contribution of scientific processes and skills to the research and development of the technology of materials.

Skills

Students will be expected to demonstrate an ability to

- design an experiment to investigate several properties of a selected material
- carry out the experimental design on a selected material(s)
- apply data collection, organization, and interpretation skills
- communicate results clearly
- propose applications of the selected material, based on its properties
- assess materials critically.

Concepts

1. *Students will be expected to* demonstrate an understanding that a material is the substance of which a thing is or from which it can be made.

   1.1 Define *matter*.
   1.2 Define the atom as the basic structural unit of matter.
   1.3 Relate the behaviour of atoms and molecules to the Kinetic Molecular Theory.
   1.4 Relate the properties of a material to its composition.

2. *Students will be expected to* demonstrate an understanding that the properties of materials can be investigated through controlled experimentation.

3. *Students will be expected to* demonstrate an understanding that the technological process of producing a product can be evaluated.

   3.1 Describe how products are derived from natural or synthetic sources.
   3.2 Identify products that are in everyday use.
   3.3 Investigate the industrial process involved in the manufacture of two products.
   3.4 State the advantages and disadvantages of the industrial processing of resources into a product.

4. *Students will be expected* to demonstrate an understanding that the use of materials has changed many aspects of life.

   4.1 Describe how non-biodegradable products can cause environmental problems.
   4.2 Assess the need for biodegradable products.
   4.3 Describe how products and their applications can change over time as new materials and technologies are developed.
   4.4 List the properties of four selected raw materials and identify their contribution to our quality of life.

Required Unit 4: Safe Transportation

Overview

Students will study the scientific principles associated with transportation.

The rationale for the technology involved in transportation safety should evolve from this study. An issue related to transportation safety should be thoroughly investigated and the student should develop an informed opinion regarding this issue.

Attitudes

Students will be encouraged to

- appreciate a philosophy of life that reflects personal responsibility
- appreciate that ethical dilemmas may arise from application of technological developments
- appreciate the relationship among science, technology, and society with respect to transportation
- accept the need for rules and regulations with respect to transportation safety.

Skills

Students will be expected to demonstrate an ability to

- select and apply appropriate problem-solving strategies
- apply data collection, organization, and interpretation skills
- apply deductive reasoning to arrive at a conclusion
- analyze the possible impact of technological development on society
- identify the limits of science and technology
- debate the relationship between consumers' expectations and producers' responsibilities
- implement principles of transportation safety that will contribute to lifelong health and survival.

Concepts

1. ***Students will be expected to*** demonstrate an understanding that collisions involve the conservation of energy.

   1.1 Relate the momentum of an object to its mass and velocity.
   1.2 Specify that moving objects possess energy of motion called kinetic energy.
   1.3 Relate the energy transferred in a collision to the direction of the moving objects involved.
   1.4 Trace the energy conversions in a collision.

2. ***Students will be expected to*** demonstrate an understanding that personal risk involved in the use of technology can be assessed.

   2.1 Investigate how different modes of travel present different types and degrees of personal risk.
   2.2 Relate the condition and expertise of the vehicle operator to degree of the risk involved.
   2.3 Relate environmental conditions to travel safety.
   2.4 Describe how risk may be reduced by use of safety devices and practices.

3. *Students will be expected to* demonstrate an understanding that trade-offs are made to arrive at safe, workable situations involving technology in society.

4. *Students will be expected to* demonstrate an understanding that the consequences of improper diet can range from minor deficiencies to life-threatening conditions.

   4.1 Specify how a lack of vitamins or minerals may lead to deficiency diseases.
   4.2 Describe how fad diets and packaged meal supplements may lack essential food groups, minerals, and vitamins and may be hazardous to one's health.
   4.3 Define/describe *anorexia* and *bulimia*.
   4.4 State why anorexia and bulimia are life threatening.
   4.5 Cite at least one example of technological advancement in health care related to nutrition.
   4.6 Analyze diet and activity level based on energy requirements and suggest improvements.
   4.7 Deduce that reducing diets are most effective when a major lifestyle change is implemented and a lasting balance of food intake and activity results.

Suggested Optional Unit: Geology

Overview

Several theories have been used to explain the existence of geological forces such as volcanoes and earthquakes. Students will examine evidence and determine how well the current theory and model explain such evidence. Activities should promote the students' understanding of the important role technologies, such as remote sensing and Richter scale determinations, play in the collection of relevant data.

Attitudes

Students will be encouraged to

- recognize that scientific knowledge is cumulative and subject to change
- appreciate the limits of science and technology in problem solving
- appreciate the ethical dilemmas that may arise from the application of scientific research and/or technological developments
- appreciate that proposed theories such as "plate tectonics" may be supported or refuted by experimental results
- appreciate the relationship between science and technology in the area of geology
- appreciate the beauty/magnitude of the earth's geological features and processes.

Skills

Students will be expected to demonstrate an ability to

- apply data collection, organization, and interpretation skills
- identify trends in data and make predictions from those trends
- use established scientific models as a comparative base for observable data
- identify components and interactions within geological systems
- use precise terminology and symbols.

Concepts

1. *Students will be expected to* demonstrate an understanding that movements of the earth's crust result in earthquakes, volcanoes, and mountain building.

   1.1 Describe theories that explain dynamic changes occurring in the earth's crust.
   1.2 Illustrate using at least one example that movement of the earth's crust is localized.
   1.3 Identify the current theory explaining the earth's internal structure.
   1.4 Assess evidence on the current theory of the internal structure of the earth.

2. *Students will be expected to* demonstrate an understanding that the forces of nature can be explained by the movement of water, air, and land.

   2.1 Assess why movement requires an energy source.
   2.2 Describe how forces cause specific patterns of movement of water, air, and land.
   2.3 Investigate and describe how movement of water, air, and land can alter the surface of the earth.

3. *Students will be expected to* demonstrate an understanding that technology can be used to predict the forces of nature.

   3.1 Assess the limitations of modern technology in measuring and accurately predicting the earth's movement using one example.
   3.2 Explain why the earth's movement can be measured, but not accurately predicted, even with modern technology.
   3.3 Describe how the technology involved in predicting the forces of nature is developing rapidly.
   3.4 Examine and describe a rapidly developing technology associated with predictions of the forces of nature.

4. *Students will be expected to* demonstrate an understanding that theories may be updated based on new evidence.

   4.1 Describe the historical development of a current theory that offers a explanation for a geological feature and/or process.
   4.2 Explain how the accumulation of data contributes to evidence that may support, modify, or refute a theory explaining a geological feature and/or process.

Suggested Optional Unit: Weather

Overview

Present-day theories and models of the earth's atmosphere attempt to explain weather phenomena such as hurricanes, tornadoes, violent storms, and general weather patterns. Students will examine the evidence and determine how well the theory and model explain such evidence. The contribution of technological data-gathering techniques and devices such as weather satellites will be considered.

Attitudes

Students will be encouraged to

- recognize that scientific knowledge is cumulative and subject to change
- identify the limits of science and technology in problem solving
- appreciate the ethical dilemmas that may arise from the application of scientific research and/or technological developments
- appreciate that proposed theories attempting to explain weather phenomena may be supported or refuted by experimental results
- appreciate the relationship between science and technology as related to the explanation and prediction of weather phenomena
- appreciate the power and magnitude of weather phenomena.

Skills

Students will be expected to demonstrate an ability to

- apply data collection, organization, and interpretation skills
- identify trends in data and make predictions from those trends
- use established scientific models as a comparative base for observable data
- use precise terminology and symbols.

Concepts

1. *Students will be expected to* demonstrate an understanding that the earth's atmosphere can be monitored for temperature, pressure, and speed.

   1.1 Relate weather patterns to the constant flux of the earth's atmosphere.
   1.2 Identify and use technology associated with measuring various characteristics of air masses.
   1.3 Investigate various weather patterns and their impact on the earth's surface.

2. *Students will be expected to* demonstrate an understanding that weather can be explained by the movement of water and air.

   2.1 Describe why movement requires an energy source.
   2.2 Identify and describe the energy sources and energy conversions involved in such movements.
   2.3 Describe how forces cause specific patterns of movement of air and water.

3. *Students will be expected to* demonstrate an understanding that technology can be used to predict the forces of nature.

   3.1 Describe how weather can be predicted and discuss why forecasts are accurate and inaccurate.
   3.2 Describe how technology plays a key role in weather forecasting.
   3.3 Describe how the technology involved in predicting the weather is developing rapidly.
   3.4 Identify and describe a rapidly developing technology associated with prediction of weather.

4. *Students will be expected to* demonstrate an understanding that theories may be updated based on new data.

   4.1 Describe the historical development of a present-day theory that offers explanation of a weather related force of nature (e.g., tornado formation).
   4.2 Explain how the accumulation of data may support, or refute, a theory that explains a weather phenomenon.

D. BASIC LEARNING RESOURCES

Science 14-Basic Resources for Required Units:

Hutton, Glen, ed. Household Science. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

—. Investigating the Environment. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

—. Science, Technology and You. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

—. Your Body in Balance. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Science 24-Basic Resources for Required Units:

Hutton, Glen, ed. Arrive Alive. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

—. Disease Defence. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

—. Energy for Living. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

—. Materials and Molecules. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Science 14-24-Basic Resources for Optional Units:

Hutton, Glen, ed. Earth Changers. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

—. Everyone Talks About the Weather. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

—. Food Power. ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.